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## STUDENT'S PERCEPTION OF SUSTAINABLE UNIVERSITY – ON THE EXAMPLE OF BIALYSTOK UNIVERSITY OF TECHNOLOGY

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**ABSTRACT:** Measuring university sustainability is an important tool for assessing and monitoring progress towards more sustainable practices and outcomes at Higher Education Institutions (HEI). This article contributes to the development of research based on stakeholders theory in universities (Miller et al., 2014), taking into account the perception of the main group of university stakeholders, i.e. students, towards sustainable university. The research objective is to empirically verify perceptions and compare the level of implementation of the sustainable university concept among students of Białystok University of Technology. In the theoretical part, a systematic literature review was conducted. The most frequent keywords related to the topic of sustainable university were also extracted as a part of the bibliometric analysis using the VOSviewer software. In the empirical part, descriptive statistics and difference tests (U-Man Whitney) were used to identify statistically significant differences between different groups of students in terms of perception of the sustainable university concept. In light of the research conducted, it can be concluded that Białystok University of Technology is making efforts in various areas of sustainable development. However, there are specific areas where improvements can be made, such as enhancing awareness among students about the university's sustainable development strategy, promoting critical thinking, and addressing uncertainties about certain campus activities and management policies. In the article, a new scale was developed to examine students' perceptions of a sustainable university. It includes 30 items, is based on the areas of sustainable development of universities discussed in previous studies, and takes into account new criteria, in particular, those related to ESG factors.

**KEYWORDS:** sustainable university, student's perception, university, sustainability assessment, ESG

## Introduction

Universities as institutions make significant social, economic, academic, scientific and technological contributions to local and national environments around the world (Kobylińska & Irimia-Dieguez, 2023; de Filippo et al., 2019; Carpenter & Meehan, 2002). The literature emphasises that universities can support the achievement of all 17 Sustainable Development Goals (SDGs) (Budzanowska-Drzewiecka et al., 2023; Filho et al., 2019).

In recent years, the concept of a sustainable university has appeared in the literature, according to which the university integrates all its activities in accordance with the principle of sustainability to contribute to the sustainable development of stakeholders (Deleye, 2023; Fisher et al., 2015; Lozano et al., 2013; Velazquez et al., 2006). There have been different approaches to the topic of a sustainable university (Deleye, 2023). One approach is the idea of a sustainable university, which emphasises the role of universities in solving future global environmental problems through education, research and community involvement (Sart, 2022; Lambrechts et al., 2013; Tumbas et al., 2015). Another approach is the concept of an engaged community, where universities actively engage their stakeholders in sustainable development initiatives (Deleye, 2023). In turn, in another discourse, there is the idea of a green-tech campus focusing on the inclusion of sustainable technologies and practices in the university's activities (Deleye, 2023; Anthony Jnr, 2021). Today, many universities are committed to sustainability by engaging in activities such as reducing carbon emissions, promoting sustainability research, introducing sustainability-related courses and curricula, and taking other measures to promote sustainable practices on their campuses and beyond (Lukman & Glavič, 2007).

There is no exact date when the concept of a "sustainable university" originated. However, it can be pointed out that the concept gained prominence in the 1990s and early 2000s as many educational institutions around the world began to engage with sustainability and innovate their curricula and operations (Lukman & Glavič, 2007; Lozano et al., 2013). The definition of a sustainable university in the literature always refers to the environmental, economic and social issues that universities should take into account in their activities and the obligation of "leading by example" (Amaral et al., 2015). One of the most cited definitions of a sustainable university is proposed by Velazquez et al. (2006) – for this author, a Sustainable Higher Education Institution is "an HEI (...) that addresses, involves and promotes, on a regional or a global level, the minimisation of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles". HEIs consider the issues of sustainable development through all structural and organisational dimensions, infrastructure and energy-related aspects, and efficient use of resources by continuing strategic actions from education, research, knowledge transfer, and stakeholders (partnerships and community). Another definition proposed by Sterling (2013) underlines that the sustainable university is: "one that through its guiding ethos, outlook and aspirations, governance, research, curriculum, community links, campus management, monitoring and modus operandi seeks explicitly to explore, develop, contribute to, embody and manifest – critically and reflexively – the kinds of values, concepts and ideas, challenges and approaches that are emerging from the growing global sustainability discourse" (Fischer et al., 2015). HEIs sustainable initiatives and activities could take place in different areas (Fischer et al., 2015; Lozano et al., 2013): research, education, campus operations, community engagement/outreach, institutional framework, on-campus experiences, assessment and reporting. A different taxonomy of sustainable activities divides them into different practices (environmental, economic, social/cultural and institutional/educational/political) (Aleixo et al., 2018; Filho et al., 2019; Lozano, 2011). Therefore, the HEIs play a catalytic role in societies' engagement with sustainability (Lehmann et al., 2009).

There is no single universal method for measuring the degree of implementation of the "sustainable university" concept. There are several different approaches to measuring that can be adapted to specific goals and contexts (Velazquez et al., 2006; Gómez et al., 2023). Based on Filho (2011), the goals of sustainability in universities can only be achieved once the attitudes of key stakeholders about sustainability are known. Cooperation with stakeholders should be part of the strategy towards sustainability (Aleixo et al., 2018). One of the most important groups of stakeholders of HEIs are students (Figueredo & Tsarenko, 2013). Students as stakeholders form expectations not only regarding the sustainability of the university in general but also in very specific detail, and the way these

expectations are met may determine their level of satisfaction (Nagy & Veresne Somosi, 2020). This article contributes to the development of research based on stakeholder theory in universities (Miller et al., 2014), taking into account the perception of the main group of university stakeholders, i.e. students, towards sustainable university. Despite the importance of improving students' awareness, skills and engagement in sustainability topics, research exploring this issue is limited (Nejati & Nejati, 2013). A better understanding of students' perceptions regarding sustainability university practice is particularly important because it can give decision-makers a good picture of the university's performance from the point of view of one of the main stakeholder groups.

Based on the above considerations, the research objective of the article is to empirically verify perception and compare the level of implementation of the sustainable university concept among students of Bialystok University of Technology (Poland). The research questions are as follows: What measurement scale can be used to identify the diagnosis of the concept of a sustainable university in the perception of students? Which sustainable university categories and variables are rated the best/worst in the analysed research group of respondents? Do variables such as gender and field of study experiences influence students' perception of a sustainable university? To answer the above questions, it was particularly important to adopt one definition of a sustainable university, defining the measurement method and research tool, collecting data on the perception of students in the context of introducing the idea of a sustainable university in their home universities, data analysis, drawing conclusions and indicating directions for the future research.

The results of the presented research may confirm the belief that this type of diagnosis is useful in the context of creating educational projects and raising social awareness in the field of a sustainable university.

## Literature review (on sustainable university concept and models of measurement)

### Sustainable university concept – the bibliometric analysis

The literature review process is a key tool used to analyse multi-faceted knowledge for a specific academic study. The purpose of a literature review is to enable the researcher to both map and evaluate the existing theoretical area and clarify the research problem in order to further develop the existing body of knowledge (Tranfield et al., 2003; Rollnik-Sadowska, 2024). The systematic literature review in this article was divided into five main stages. The first step is to search for literature for analysis. In the next stage, publications in the database were selected by introducing selected search filters. The third and fourth stages were devoted to bibliometric analysis, basic elements of analysis and citation analysis, respectively. The fifth stage was the analysis of connections between thematic clusters occurring in the examined issue.

The research stages, along with the activities performed within them and the number of articles, are presented in Table 1.

**Table 1.** Stages of search results

No	Stage	Description
1	Searching for literature for analyses	1. Bibliografic database selection: Clarivate Web of Science (WoS)
2	Cleaning the database	1. Filtering language: English 2. Filtering type of document: Articles 3. Abstract review 4. Identification of articles for analysis
3	Basic bibliometric analysis	1. Analysis of the number of publications by year, most frequently cited authors, journals, countries
4	Identification of main research areas	1. Visualization of the most frequently occurring keywords (Vos Viewer software)
5	Thematic cluster analysis	1. Thematic cluster visualization and analysis

The results were developed and presented with the support of the VOSviewer software, which allowed the preparation of a map showing the existing connections between the keywords indicated by the authors of the articles (Szydło et al., 2024). When it comes to analysis, the minimum number of occurrences was set to 5. As a result, the number of keywords in the WoS database was 1152.

The group of articles for the study was selected from the Web of Science database in September 2023. WoS is the most popular bibliographic and abstract database, which is known for the high quality of accumulated resources (Szpilko & Ejdyś, 2022; Szpilko et al., 2023).

In the sample selection process, data analysis for the purposes of this literature review began with a broad set, which was gradually reduced in subsequent stages. Firstly, the bibliometric analysis covered publications containing the phrases “sustainable university” OR “sustainable HEI”. The initial search in the first attempt included publications containing the indicated phrase in the entire range of documents, while in the second attempt – in titles, summaries and keywords. Selected exclusion criteria were then applied. Materials published between 2000 and 2022 were searched. Only articles qualified for further analysis. Because most review studies usually only analyse articles from journals, the search logic followed this lead.

Other types of publications were rejected. The results of the initial search are presented in the table. Search for “sustainable universit\*” OR “sustainable HEI\*” in various publications. The first attempt generated 399 records in WoS. The use of asterisks indicates different abbreviations of these terms, their plurality and different spellings, which results in the highest number of publications. A preliminary analysis of the results showed that many publications had no connection with the researched topic. Therefore, in the second attempt, the search was limited only to publications containing the indicated phrase, abstracts and keywords in the title. After searching for the phrase in titles, abstracts and keywords, it was obtained 283 in Web of Science. After adopting additional limiting criteria (only articles in the English language), the results were narrowed to the number of 224 publications. The results of the search pre-selection are presented in Table 2.

Table 2. Search results (preliminary)

First stage	Web of Science database
Research query	ALL Fields = („sustainable universit*” OR „sustainable HEI*“)
Number of publications	399
Number of publications after inclusion criteria (only articles, language: english)	283
Second stage	
Research query	TS = („sustainable universit*” OR „sustainable HEI*“)
Number of articles	336
Number of articles after inclusion criteria (articles, language)	224

Files containing the full description of records in \*csv format were downloaded from WoS database. Scientific productivity in the area of the “sustainable university” concept was assessed based on the annual number of publications. Countries leading in research were recognised. The authors’ publishing activity was analysed. Then, a bibliometric citation analysis was performed. The most frequently cited authors, the most frequently cited articles and the most important journals were distinguished.

Interest in the concept of a sustainable university began in the early 2000s. It can be noticed that this perspective is not widely spread in the scientific literature. However, it is a gradual increase in interest can be observed by the increase in the number of publications registered in selected databases over the last twenty years (Figure 1). This proves the growing interest of scientists in the analysed topic.

The largest number of publications was published in 2020 (35). According to the subject area criterion, most publications were published in journals such as Science Technology (114), Environmental Science Ecology (91) and Education Educational Research (67) (Figure 2).

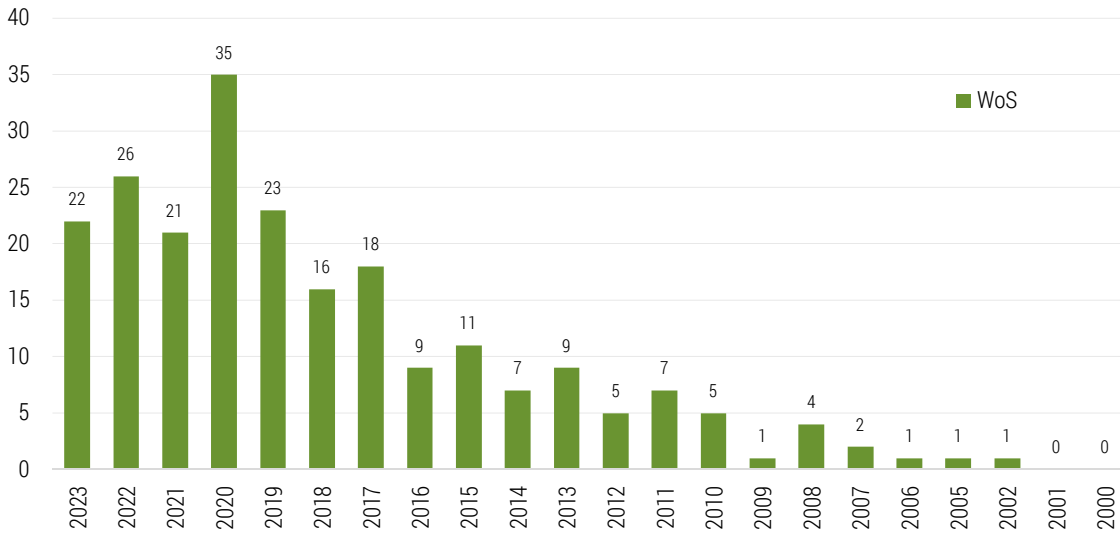


Figure 1. Number of publications on the subject: “sustainable university” per year in the database WoS

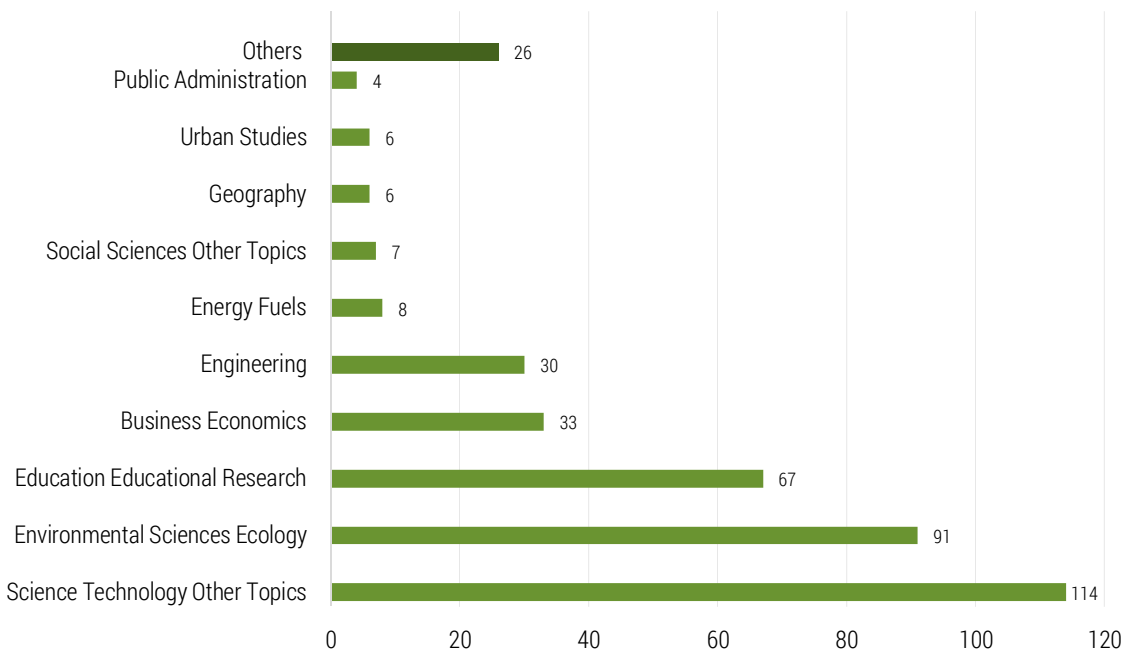


Figure 2. Articles by subject area – database WoS

The most productive journals with publications on the subject are: “Sustainability” (44), “International Journal of Sustainability in Higher Education” (24) and “Journal of Cleaner Production” (23) (Table 3). The authors with the highest number of publications are W. Leal (7 articles) and B. F. Gianetti (4 articles). The vast majority of authors published three articles each or less (Table 3).

The most cited article (394 citations in WoS) was “Sustainable University: what can be the matter” (2006) from the “Journal of Cleaner Production”. The first four most cited articles are from the Journal of Cleaner Production (Table 4). As you can see, in recent years, there have not been many significant articles on the topic of sustainable universities, which may justify the need to delve deeper into this topic and refer to the most current context.

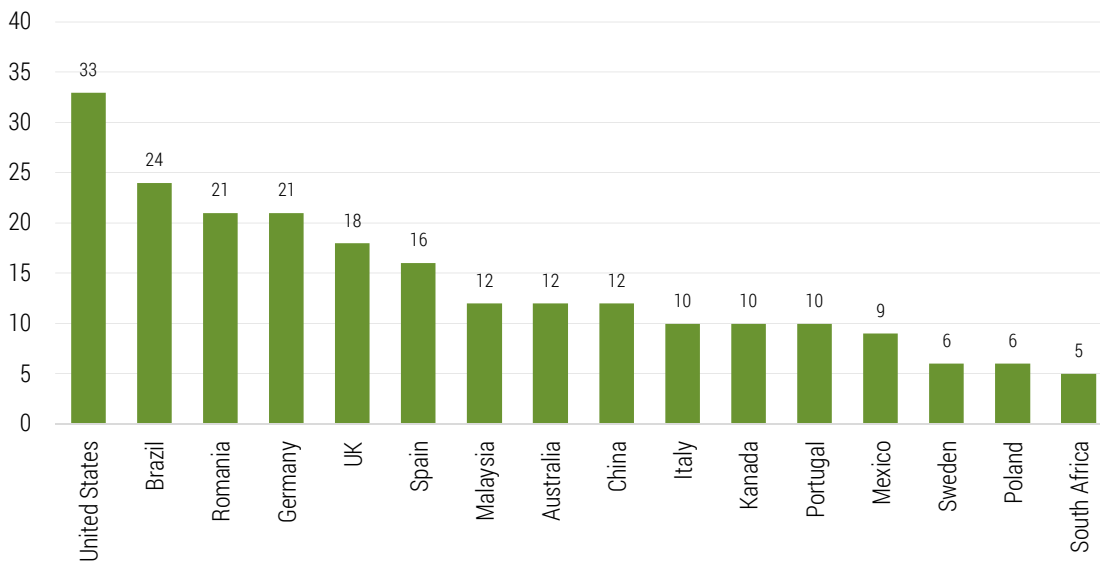


Figure 3. Countries leading in publishing

Table 3. The most productive journals

No	Item	Number of articles and IF of Journal	Average citation WoS
<b>Journals</b>			
1	Sustainability	44 (IF – 3,9)	41
2	International Journal of Sustainability in Higher Education	24 (IF – 3,1)	24
3	Journal of Cleaner Production	23 (IF- 11,072)	22
4	Amfitetru Economic	12 (IF- 2,304)	12
5	World Sustainability Series	11 (IF – 0,6)	11
6	Environmental Education Research	3 (IF-3,70)	3
7	International Journal of Environment and Sustainable Development	3 (IF-0,98)	3

Table 4. The most frequently cited articles

Authors	Article	Journal	Number of citation
Velazquez et al. (2006)	Sustainable university: what can be the matter?	Journal of Cleaner Production	394
Barth and Rieckmann (2012)	Academic staff development as a catalyst for curriculum change towards education for sustainable development: an output perspective	Journal of Cleaner Production	198
Disterheft et al. (2015)	Sustainable universities – a study of critical success factors for participatory approaches	Journal of Cleaner Production	163
Ramos et al. (2015)	Experiences from the implementation of sustainable development in higher education institutions: Environmental Management for Sustainable Universities	Journal of Cleaner Production	157
Brinkhurst et al. (2011)	Achieving campus sustainability: top-down, bottom-up, or neither?	International Journal of Sustainability in Higher Education	147

Authors	Article	Journal	Number of citation
Theodoraki et al. (2018)	A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study	Small Business Economics	139
Ferrer-Balas et al. (2010)	Going beyond the rhetoric: system-wide changes in universities for sustainable societies	Journal of Cleaner Production	127

Source: authors' work based on the Web of Science database.

The most frequent keywords related to the topic of sustainable university were also extracted as part of the bibliometric analysis. The VOSviewer software (version 1.6.19) was used during the analysis. To analyse the occurrence of the majority of terms used by the authors in their research about “sustainable university” a trend map was created on the basis of bibliographic data on co-occurrence keywords used by authors in the WoS database.

1,152 keywords were identified in the analysed database, of which 54 appeared at least 3 times.

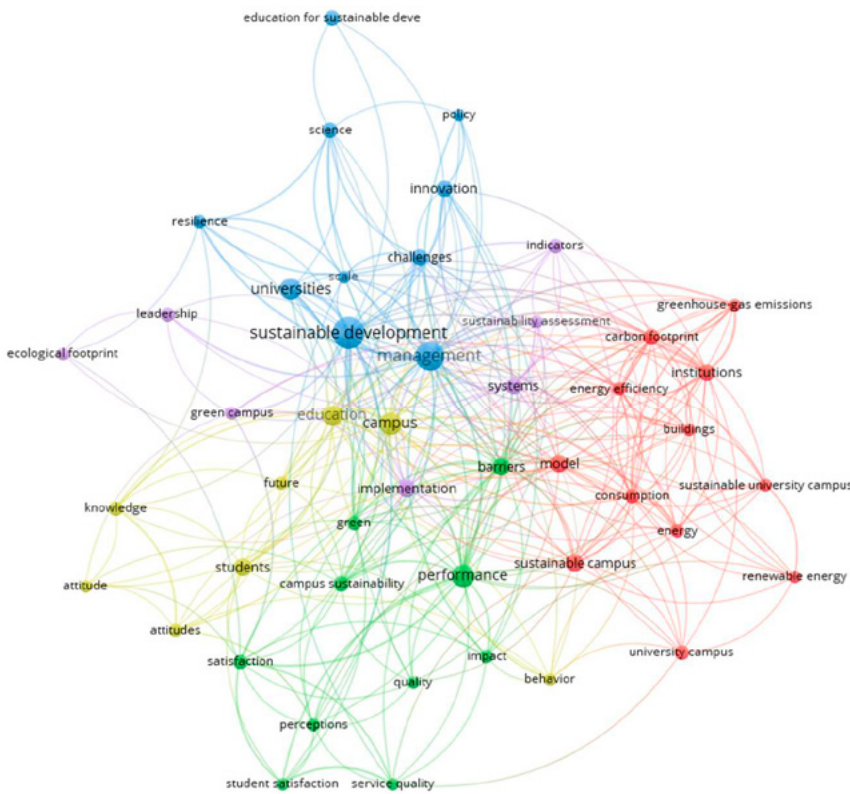


Figure 4. Map of research trends in the subject “sustainable university” – WoS database

Source: authors' own work using the VOSviewer software.

The set contained words with the same meaning as abbreviations or repetitions and words not directly related to the subject of analysis. They have been removed. The final set contained 46 keywords.

Then, based on keyword analysis and an in-depth review of the publication collection, thematic clusters depicting the main and emerging research directions were identified (Table 5).

**Table 5.** Clusters and words related to cluster

No of cluster	Name of cluster	Words
1	Sustainable use of resources/sustainable practices	Buildings, carbon footprint, consumption, energy consumption, green-house gas emission, model, renewable energy
2	Educational experience and awareness in the context of sustainability	Barriers, campus sustainability, green impact, perception, performance, satisfaction, quality service, students satisfaction
3	Main role in addressing complex sustainability challenges/innovations/research	Challenge, education for sustainability, innovation, management, policy, resilience, science, sustainable development
4	Role of education	Attitudes, behaviour, campus, education, future, knowledge, students, sustainability
5	Measurement	Ecological footprint, green campus, implementation, indicators, leadership, sustainability assessment, leadership, system

**The first cluster** in WoS database includes seven keywords (Table 5). These words and concepts are interconnected through the topic of sustainability, especially in the context of a university or campus environment. Efforts to reduce energy consumption, greenhouse gas emissions, and overall resource use contribute to the development of a sustainable university or campus model. The green operation of buildings on a university campus plays a key role in sustainability efforts because they can contribute to environmental impacts. Reducing the university community's carbon footprint is a key sustainability goal. Sustainable practices often involve reducing the overall use of resources such as water, energy, and materials, so sustainable campuses strive to reduce greenhouse gas emissions to mitigate their environmental impact. In summary, the words and concepts gathered in the first cluster are interconnected through the theme of sustainable practices and include efforts to reduce energy consumption, greenhouse gas emissions and overall resource consumption to contribute to development.

**The second cluster** in WoS database includes eight keywords. The commonality among these words is that they are all related to the discussions about improving the educational experience and environment for students in the context of sustainability. Barriers refer to obstacles or challenges that may make it difficult to achieve the stated goals of a sustainable university. Campus sustainability focuses on the efforts and initiatives to promote sustainability and reduce their environmental impact. Environmental impact refers to the positive impacts and outcomes of sustainability initiatives and environmental activities undertaken on a campus or educational institution. Perceptions refer to how students, faculty and stakeholders view various aspects of a university, including its quality, services, and sustainability efforts. Performance refers to the overall effectiveness and outcomes of an institution's educational programs, services and activities regarding sustainability. Satisfaction reflects student and stakeholder satisfaction with their educational experiences, including the quality of educational services and campus sustainability efforts. In summary, these words all apply to the context of higher education institutions and are often used in discussions about improving the learning environment by considering students' experiences of sustainability.

**The third cluster** is represented by words classified in this category in the context of addressing global challenges related to sustainable development. To achieve sustainable development, appropriate education is crucial. It focuses on equipping students with the knowledge and skills needed to understand, promote and implement sustainable practices. Scientific research are also fundamental to understanding the challenges facing our planet, such as climate change, biodiversity loss and resource depletion. Technological, social and organisational innovations can accelerate progress towards the Sustainable Development Goals. Building resilience is important in the face of environmental and social challenges. In summary, the words in this cluster are interconnected through their role in addressing complex sustainability challenges. Education for sustainability and innovation drives knowledge and progress, while science shapes policies and management practices to achieve sustainability and resilience in the face of global challenges.

Words from the **fourth cluster** are related to each other in the context of education and the development of students' knowledge. Education refers to the process of acquiring knowledge, skills,



values and attitudes regarding sustainable development. Education can take place in a variety of places, including campuses. This could be a university or any place where students gather for educational purposes. Students are people who engage in the educational process about sustainable development on campus. Attitudes can play a key role in shaping students' approach to appropriate pro-sustainable behaviour in the future. To summarise, the words in this cluster are connected to each other through the educational process. Knowledge is its result, attitudes and behaviours may influence students' approach to sustainable development in the future.

**Cluster 5** words are related to the topic of assessing and measuring green campus efforts, implementing sustainable practices, measuring through indicators, leadership in sustainability efforts, and an overall performance evaluation system. Sustainability assessment is a process of examining the impact of universities on the environment and society. It covers not only assessment but also sustainable campus practices and activities. The ecological footprint is often used as an indicator of sustainability. A green campus is one that focuses on sustainable development in its activities and practices. Implementation refers to the action of implementing sustainability initiatives and plans on campus. It includes implementing the strategies and actions necessary to make the campus more environmentally friendly. In turn, indicators or measures are used to assess the progress and results of sustainability initiatives. These indicators may include, for example, energy consumption, waste reduction, carbon dioxide emissions and others. In the context of sustainability, leadership refers to the role of individuals, groups or institutions in leading and inspiring others to adopt and implement sustainable practices.

## Methodology

The scale for measuring "sustainable university" includes 30 items and is a construct developed by the authors on the basis of a literature review. It is based on the areas of sustainable university discussed in previous studies and includes new criteria.

We believe that existing models in the literature can be improved adapting them even more to the contemporary challenges faced by sustainable universities. The starting point was the research of Lozano et al. (2013) and Gómez et al. (2023). Also included are the previously discussed theoretical models developed by Nagy and Veresne Somosi (2020), Nejati and Nejati (2013).

Three perspectives of ESG were also taken into account when thinking about a sustainable university: environmental, social and governance. In the context of a sustainable university, ESG can refer to many different aspects: ESG education and awareness programs (including environmental, social, ethical issues); research and publications (in the field of ESG factors); investments consistent with ESG principles (e.g. investing university financial resources in projects and companies that meet specific sustainable development criteria); university management practices consistent with ESG (universities can take actions to protect the environment, promote diversity and social equality and apply ethical standards in their actions). Incorporating ESG principles into university life can help shape a society that is more aware and engaged in sustainable development issues.

In the case of sustainable universities, the indicators should cover the entire system to address (a) Education and awareness (referring to Courses and Curricula), (b) Research and Innovation challenge, (c) Campus operations, (d) Community outreach and (e) Governance.

We include (as latent variables) five aspects of the model of a sustainable university, which we also demonstrate as important clusters of topics addressed in the literature in the context of a sustainable university:

1. *Education and Awareness (EA): empower students and citizens for sustainable development.*
2. *Research and innovation challenge (RI): discover answers to important social, environmental and ethical questions.*
3. *Campus Operations (CO): achieve a zero footprint for campus operations.*
4. *Community Outreach and Collaboration (COC): empower and engage students, staff and society to act on sustainability.*
5. *Governance and Measurement (GM): make sustainability a visible priority for University.*

The appendix contains a proposal for a research tool to measure a sustainable university. The measurement model contains 5 latent variables and 30 items.

In this study, simple descriptive statistics (mean, standard deviations) were used to analyse the survey results. The Mann-Whitney U test was used for statistical analysis of differences between groups of students.

## Results

The study was conducted in the fourth quarter of 2023. 184 students of the Bialystok University of Technology (Poland) took part in a survey (55.5% were men, 47.8% – women, 1.7% – other gender). Among the respondents, 70% studied social sciences and 30% technical sciences.

For each of the 30 statements, the respondents marked one of five answers: from “definitely not” to “definitely yes” (a five-point Likert scale was used).

High-reliability rates were obtained for the tool developed by the authors. It turned out that Cronbach’s alpha for the Education and Awareness area was 0.88, for the Research and Innovation: 0.88, for the Campus Operations: 0.85, for the Community Outreach and Collaboration: 0.87 and for the Governance and Measurement area: 0.86.

In light of the obtained research results, it should be stated that Polish students evaluate the University’s sustainable activities in the area of Education and Awareness moderately well (average: 3.46). However, they cannot determine whether the courses taught promote critical thinking about sustainable development (average: 3.09), and they are also not aware of the implementation of the assumptions of the sustainable development strategy of their university (average: 3.17). They have a moderately positive attitude towards the offered study programs (average: 3.67) and subjects/courses (average: 3.65) related to sustainable development. Additionally, they do not particularly note much information about sustainable development during compulsory classes (average: 3.24). They have a slightly better attitude towards the introduction of equality and diversity policies (average: 3.84) and the organisation of educational events aimed at informing students and the academic community about the importance of sustainable development (average: 3.59). Polish students also rate the University’s sustainable activities in the area of Research and innovation moderately well (average: 3.58). They rather believe that the University supports research on sustainable development through funds, scholarships and other incentives (average: 3.82). However, they do not know whether it favours research projects on sustainable development in the environmental and social areas (average: 3.32). They tend to agree with the statements that the University engages students in research on sustainable development (average: 3.58), uses research results in the area of sustainable development in teaching (average: 3.53) and promotes research in this field (average: 3.66). The next area – Campus Operations, was also rated moderately positively by Polish students (average: 3.48). Respondents appreciate the University’s facilities for people with disabilities (average: 4.12). They have a relatively positive attitude to the number of outdoor spaces and areas supporting vegetation, trees and biodiversity (average: 3.89) and the possibility of selective waste collection (average: 3.99). They tend to have no opinion on the University’s implementation of policies and activities regarding the use of renewable energy (average: 3.45) and programs aimed at reducing the use of paper and plastic on campus (average: 3.30). They are relatively critical of the University’s promotion of sustainable mobility, its policy of restricting motor vehicle traffic and encouraging the use of bicycles and pedestrian paths (average: 2.86). They also do not know whether the University implements a water protection program (average: 3.06) and whether buildings are designed to save energy (average: 3.15).

The respondents concluded that the University was doing relatively well in the area of Community Outreach and Collaboration (average: 3.64). Rather, it collaborates with other universities in the sphere of sustainable development (average: 3.72), establishes partnerships with entities outside the sector to support sustainable development (average: 3.70), and engages in social programs that benefit the local environment (average: 3.74). Students emphasised that student organisations act to protect the environment to a moderate extent (average: 3.52) and that the University encourages students and employees to participate in pro-ecological activities (average: 3.50). It should be noted that this area was rated the best by the respondents. The last area that was analysed was governance and measurement. It was rated slightly worse than the others (average: 3.44). The statement that the University has an employment policy that respects diversity, disabilities and ethnic minorities was

rated relatively positively (average: 3.86). Students responded moderately positively to the issue of implementing the principles of sustainable development in university policy (average: 3.43). They also tended to agree with the statement that the University has a sustainable work policy that is intended to generate greater benefits for its employees (average: 3.43). However, they did not have sufficient knowledge about the University's written commitment to supporting sustainable development (average: 3.27) and presenting environmental reports (average: 3.21). Detailed results are presented in Table 6.

**Table 6.** Sustainable development in students perception in five categories – descriptive statistics

Item number	N=184		Category	Mean
	Mean	St D		
1	3.10	1.16	EA	3.46
2	3.17	1.10	EA	
3	3.67	1.08	EA	
4	3.65	1.11	EA	
5	3.24	1.24	EA	
6	3.84	1.06	EA	
7	3.59	1.18	EA	
8	3.82	1.00	RI	3.58
9	3.32	0.97	RI	
10	3.58	1.04	RI	
11	3.53	1.05	RI	
12	3.66	1.03	RI	
13	3.89	1.14	CO	3.48
14	3.45	1.02	CO	
15	3.30	1.23	CO	
16	2.86	1.21	CO	
17	3.07	1.03	CO	
18	3.99	0.97	CO	
19	3.15	1.14	CO	
20	4.12	1.02	CO	
21	3.72	0.93	COC	3.64
22	3.70	0.93	COC	
23	3.74	0.90	COC	
24	3.52	0.99	COC	
25	3.50	1.07	COC	
26	3.43	0.96	GM	3.44
27	3.27	1.01	GM	
28	3.43	0.94	GM	
29	3.86	1.04	GM	
30	3.21	0.94	GM	

AE: Education and Awareness; RI: Research and Innovation; CO: Campus Operations; COC: Community Outreach and Collaboration; GM: Governance and Measurement.

The real challenge seems to be proper preparation for implementing the principles of sustainable development in various areas. It may seem that gender is a variable that matters in this topic. It was assumed that women may be more sensitive to initiatives related to the need to function in a sustainable reality. The Mann-Whitney U test was used to statistically analyze indicators. The results are presented in Table 7.

**Table 7.** Sustainable university student' perception (gender, field of study)

Item no.	Man (N=93)		Women (N= 88)		U Man-Whitney test		Students of social field of study (N=129)		Students of technical field of study (N=55)		U Man-Whitney test		Category
	Mean	St d	Mean	St d	Z	p	Mean	St d	Mean	St d	Z	p	
1	3.13	1.13	3.13	1.16	-0.01	0.99	3.05	1.16	3.22	1.15	-0.93	0.35	EA
2	3.12	1.09	3.27	1.07	-1.00	0.32	3.27	1.09	2.93	1.09	2.25	0.02	EA
3	3.69	1.06	3.72	1.04	-0.19	0.85	3.74	1.05	3.51	1.14	1.38	0.17	EA
4	3.66	1.05	3.73	1.09	-0.58	0.56	3.71	1.10	3.51	1.14	1.14	0.25	EA
5	3.09	1.24	3.47	1.19	-2.02	0.04	3.36	1.21	2.95	1.28	2.09	0.04	EA
6	3.73	1.01	3.99	1.09	-2.19	0.03	3.87	1.12	3.78	0.90	1.15	0.25	EA
7	3.46	1.17	3.78	1.15	-1.95	0.05	3.72	1.14	3.29	1.23	2.29	0.02	EA
8	3.80	0.96	3.92	0.96	-0.96	0.34	3.90	0.98	3.64	1.02	1.83	0.07	RI
9	3.30	0.89	3.38	1.04	-0.76	0.44	3.26	0.99	3.45	0.92	-0.98	0.33	RI
10	3.48	1.00	3.73	1.05	-1.87	0.06	3.68	1.01	3.35	1.08	2.04	0.04	RI
11	3.48	1.05	3.60	1.03	-1.00	0.32	3.62	1.01	3.31	1.12	1.88	0.06	RI
12	3.56	0.96	3.80	1.06	-2.04	0.04	3.71	1.03	3.56	1.05	1.18	0.24	RI
13	4.02	1.05	3.80	1.18	1.32	0.19	3.95	1.08	3.75	1.27	0.79	0.43	CO
14	3.47	1.10	3.47	0.93	0.39	0.70	3.29	1.02	3.82	0.94	-3.26	0.00	CO
15	3.25	1.20	3.41	1.26	-0.98	0.33	3.36	1.22	3.18	1.28	0.84	0.40	CO
16	2.66	1.15	3.08	1.25	-2.32	0.02	2.90	1.19	2.78	1.26	0.80	0.42	CO
17	2.97	0.95	3.16	1.10	-1.28	0.20	3.09	1.04	3.02	1.03	0.59	0.56	CO
18	3.97	0.91	4.01	1.03	-0.81	0.42	3.91	1.05	4.18	0.70	-1.11	0.27	CO
19	3.06	1.15	3.27	1.12	-1.01	0.31	3.22	1.12	2.98	1.18	1.29	0.20	CO
20	4.13	0.96	4.13	1.09	-0.45	0.65	4.02	1.06	4.36	0.87	-2.14	0.03	CO
21	3.72	0.94	3.74	0.94	-0.18	0.86	3.71	0.99	3.75	0.78	0.13	0.90	COC
22	3.61	0.87	3.83	0.95	-1.72	0.09	3.67	0.99	3.76	0.77	-0.15	0.88	COC
23	3.58	0.89	3.94	0.89	-2.88	0.00	3.74	0.95	3.75	0.80	0.32	0.75	COC
24	3.25	0.95	3.82	0.95	-4.06	0.00	3.61	1.03	3.29	0.88	2.53	0.01	COC
25	3.23	1.00	3.78	1.07	-3.78	0.00	3.60	1.04	3.27	1.10	1.88	0.06	COC
26	3.27	0.91	3.60	0.99	-2.28	0.02	3.51	0.93	3.24	1.00	1.93	0.05	GM
27	3.19	1.00	3.38	1.00	-1.30	0.19	3.42	0.97	2.91	1.01	3.35	0.00	GM
28	3.33	0.95	3.56	0.93	-1.65	0.10	3.47	0.94	3.33	0.94	1.33	0.18	GM
29	3.71	1.07	4.01	1.00	-2.08	0.04	3.88	1.08	3.82	0.96	0.65	0.51	GM
30	3.10	0.82	3.40	0.99	-2.28	0.02	3.31	0.97	2.98	0.85	2.21	0.03	GM

Men's mean: 3.43; Women's mean: 3.63; Social studies' mean: 3.55; Technical studies' mean: 3.42.

Z – Man-Whitney U test; p – level of statistical significance.

The analysis of the relationship between gender and issues related to the sustainable development of the University shows that women are more sensitive in this respect than men. Statistically significant differences appear in the case of 10 statements: 3 refer to the areas of (COC), (GM), 2 to (EA) and 1 to (RI) and (CO). Women, to a greater extent than men, notice the University's involvement in social programs that benefit the local environment, the activities of student organisations dealing

with environmental protection, and University initiatives encouraging students and employees to participate in pro-ecological projects. They rate the implementation of the principles of sustainable development at the University, the environmental reports and the employment policy that respects diversity, disabilities, and ethnic minorities relatively higher. They pay more attention to the information provided during classes on sustainable development. They also appreciate the research aspect in this area. They also focus more on issues promoting sustainable mobility, policies to restrict motor vehicle traffic, and encouraging the use of bicycles and pedestrian paths. They rate the University's introduction of the equality and diversity policy more highly.

Another analysed problem concerns the approach to issues related to the sustainable development of universities for students of social and technical field of study (Table 7). The analysis of the relationship between the type of field of study and issues related to the sustainable development of the University shows that representatives of social studies better evaluate the University's activities in four out of five areas, i.e., EA (3 differences), GM (2 differences), RI and COC (1 difference). Respondents from the social field of studies to a greater extent than from technical studies, believe that students are aware of their university's sustainable development strategy, notice and appreciate educational events for sustainable development and the activities of student organisations in relation to environmental protection. They rate the University's involvement of students in research on sustainable development relatively higher. They are more familiar with the written commitments necessary to support sustainable development and the environmental reports created by the University. Only 2 statements in the area of Campus Operations were rated better by students in the technical field than in the social field of study. They are concerned with issues related to policies and activities related to the use of renewable energy and the university's facilities for people with disabilities.

## Conclusions, limitations and future research

Sustainable development is one of the key challenges for universities in the XXI century (Koehn & Utito, 2017; Blasco et al., 2020). Measuring students' perceptions about a sustainable university provides important information that can be used to improve sustainable activities, engage the academic community and shape a positive image of the university in the context of sustainable development. The research presented in this article provides certain conclusions regarding the state of activities in the area of sustainability and the desired directions of changes for one of the technical universities in Poland. Polish students generally rated the University's sustainable activities as average. Assessment in the area of Education and Awareness was moderately good. However, there is space for improvement, particularly in terms of promoting critical thinking about sustainable development and enhancing awareness of the university's sustainable development strategy. The respondents displayed a moderately positive attitude towards the offered study programs and subjects related to sustainable development, although there was a need for increased information dissemination during compulsory classes. The University's sustainable activities in the area of Research and Innovation were also moderately well-received. Students believed in the University's support for research on sustainable development but expressed uncertainty about its focus on environmental and social areas. Polish students generally appreciated campus facilities, particularly those for people with disabilities, outdoor spaces, and selective waste collection. However, there were concerns and a lack of clarity on certain aspects, such as sustainable mobility and energy-saving measures in buildings. The University received positive ratings for Community Outreach and Collaboration, including partnerships with other universities and entities supporting sustainable development. Student organisations and engagement in pro-ecological activities were also recognised positively. Governance and Measurement domain received a slightly lower average rating. While aspects like employment policies and sustainable work policies were acknowledged, there was a lack of knowledge about the University's written commitment to support sustainable development and environmental reporting.

In summary, the study suggests that Bialystok University of Technology is making efforts in various areas of sustainable development, but their level is not high. However, there are specific areas where improvements can be made, such as enhancing awareness among students about the university's sustainable development strategy, promoting critical thinking, and addressing uncertainties about certain campus activities and management policies. The findings highlight the importance of

proper preparation for implementing sustainable development principles, with potential considerations for gender as a relevant variable in this context. Women demonstrate a greater sensitivity to the University's involvement in social programs benefiting the local environment, as well as the activities of student organisations dedicated to environmental protection. Women also rate the implementation of sustainable development principles, environmental reports, and the employment policy respecting diversity, disabilities, and ethnic minorities higher than men. They also show a higher appreciation for the introduction of equality and diversity policies. They pay more attention to the information provided during classes on sustainable development, demonstrating a heightened awareness of the university's sustainable development strategy. Women focus more on issues promoting sustainable mobility, policies restricting motor vehicle traffic, and encouraging the use of bicycles and pedestrian paths. In the context of the field of study, students in social studies generally evaluate the university's activities in these areas more positively than their counterparts in technical studies. Social studies students believe that students are more aware of their university's sustainable development strategy and appreciate educational events for sustainable development, and they rate the university's involvement of students in research on sustainable development relatively higher. Social studies students are more familiar with the written commitments necessary to support sustainable development and the environmental reports created by the University. On the other hand, technical studies students rate two aspects—policies and activities related to the use of renewable energy and the University's facilities for people with disabilities—more positively than social studies students.

In summary, the study highlights that women generally exhibit a higher sensitivity to sustainable development issues, showing greater awareness and appreciation for various aspects of university initiatives. Furthermore, students in social studies tend to evaluate the university's sustainable activities more positively across multiple domains compared to their counterparts in technical studies. These findings underscore the importance of considering both gender and field of study in developing and implementing sustainable development strategies within university settings.

The research presented in this article has several **limitations**. Firstly, it is related to the specificity of the respondent. Students of technical universities may have specific experiences, priorities and expectations regarding the activities of a sustainable university. This may influence their assessment of sustainable activities, and standards and expectations vary depending on the field of study. Cultural aspects can also influence perceptions of sustainable practices. What is considered sustainable in one cultural context (region, country) may be assessed differently in another. Moreover, the Likert scale used may produce results that are relatively general. Lack of a deep understanding of the details can make it difficult to accurately identify areas for improvement. The perception studies did not take into account external factors, such as the financial conditions of universities or the impact of national policy in the field, which may also influence sustainable practices. Subsequent research should be designed by taking into account the specificity of technical universities, the diversity of respondents, and the use of various data collection methods, such as interviews, focus groups, and analyses of university documents. It is also important to take into account the wider context and regularly update the research to monitor possible changes in students' perceptions of a sustainable university. Additionally, the research focuses on perceptions of sustainability practices rather than measuring the actual impact and effectiveness of these practices. Perception does not always match reality, and it is important to evaluate the actual results of a university's sustainability efforts. Addressing these limitations would require a more detailed methodological description, including sample characteristics, statistical analysis methods, accounting for confounding variables, and possibly a mixed methods approach to obtain both quantitative and qualitative data.

By addressing these suggestions, **future research** can provide more robust insights into the relationship between gender, field of study, and sustainable development in universities, ultimately leading to more effective and inclusive sustainability practices. In future studies, the authors should include a larger and more diverse sample of students, as well as scientists and administrative staff, to ensure that the results are representative of the entire university community. Qualitative methods such as interviews or focus groups should be used to explore why women and social science students rate certain aspects of sustainability more highly. This can uncover hidden motivations and attitudes. Also important could be to compare findings with those of other universities to identify common trends and unique aspects of the institution's approach to sustainability. Future research could also

focus on collecting data on actual sustainability behaviours (e.g. recycling habits and participation in sustainability events) to see if perceptions are aligned with actions. It would also be a recommendation to take into account the cultural and regional context of the university to understand how local factors may influence perceptions of sustainability.

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## The contribution of the authors

Conceptualization, U.K., E.R.-S., D.S., J.S. and M.G.G.; methodology, U.K., E.R.-S., D.S., J.S. and M.G.G.; software, U.K., E.R.-S., D.S. and J.S.; validation, U.K., E.R.-S., D.S., J.S. and M.G.G.; formal analysis, U.K., E.R.-S., D.S., P.G. and J.S.; investigation, U.K., E.R.-S., D.S. and J.S.; writing, U.K., E.R.-S., D.S., P.G., J.S. and M.G.G.

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## Appendix

### Sustainable University Scale

Rate the following statements describing the categories of the sustainable university concept at your home university on a scale of 1-5.

Likert scale 1:5; 1 – strongly disagree; 5 – strongly agree.

Construct of sustainable university

Pre-established latent variable	Items, rated on scale: 1-5 (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree)
Education and Awareness (EA)	EA1: I perceive that the subjects at my University promote critical thinking about sustainability. EA2: I perceive that students are aware of the sustainability strategy of the university. EA3: I perceive that, the university offers a lot of study programmes related to sustainability. EA4: I perceive that, the university offers a lot of subjects/courses related to sustainability. EA5: I perceive that, there is also a lot of information about sustainability in normal courses. EA6: I perceive that my university introduced policy for equality and diversity. EA7: I perceive that my university organizes educational events to inform students and the academic community about the importance of sustainable development.
Research and Innovations (RI)	RI1: I perceive that my University supports research on sustainability with a budget, funds, scholarships and incentives. RI2: I perceive that the research projects in sustainability of my University have favoured and have been applied in environmental, commercial and social projects. RI3: I perceive that sustainability research at my University involves students. RI4: I perceive, that my University is using sustainable development research in the teaching. RI5: I perceive that my University promotes sustainability research.
Campus Operations (CO)	CO1: I perceive that my University has enough outdoor spaces, favourable areas for vegetation, trees and biodiversity. CO2: I perceive that my University has policies and actions for the use of renewable energies. CO3: I perceive that my University has programs to reduce paper and plastic on campus. CO4: I perceive that my University promotes sustainable mobility, policies to limit the use of motor vehicles and encourage the use of bicycles and pedestrian paths. CO5: I perceive that my University applies the water conservation program. CO6: I perceive that separate waste collection is possible on campus, and my University encourages everyone to do so. CO7: I perceive that the university buildings are designed / converted in an energy efficient and sustainable way (e.g. windows, doors, insulation). CO8: I perceive that my University has facilities for disable people.
Community Outreach and Collaboration (COC)	COC1: I perceive that there is collaborative work with other universities to contribute to the construction of a sustainable campus. COC2: I perceive, that my university has created partnerships with government, non-governmental organizations, and industry working toward sustainability. COC3: I perceive that my University engages in community outreach programs that benefit the local environment. COC4: I perceive that my University has active environmental student organization(s). COC5: I perceive, that my university provide incentives for students and employee to participate in environmentally friendly activities.
Governance & Measurement (GM)	GM1: I perceive that my University has implemented sustainability in the Institutional Policies. GM2: I perceive that my University has a written commitment (agreement) to support sustainability and is known to the students. GM3: I perceive that my University has sustainable work policies to generate greater benefits for its employee. GM4: I perceive that my University has employment policies that are respectful of diversity, disability and ethnic minority issues. GM5: I perceive, that my University presents environmental reports.

Source: authors' own study based on Gómez et al. (2023), Nagy and Veresne Somosi (2020), Lozano et al. (2013), Nejati and Nejati (2013), Velazquez et al. (2006).

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## POSTRZEGANIE PRZEZ STUDENTÓW ZRÓWNOWAŻONEJ UCZELNI – NA PRZYKŁADZIE POLITECHNIKI BIAŁOSTOCKIEJ

**STRESZCZENIE:** Pomiar zrównoważonego rozwoju uczelni jest ważnym narzędziem oceny i monitorowania postępów w kierunku zrównoważonych praktyk i wyników w instytucjach szkolnictwa wyższego (HEI). Artykuł ten przyczynia się do rozwoju badań opartych na teorii interesariuszy (Miller i in., 2014), uwzględniając postrzeganie głównej grupy interesariuszy uczelni, czyli studentów, w temacie uczelni zrównoważonej. Celem badań jest empiryczna weryfikacja postrzegania poziomu realizacji koncepcji zrównoważonej uczelni wśród studentów Politechniki Białostockiej. W części teoretycznej przeprowadzono systematyczny przegląd literatury. W ramach analizy bibliometrycznej za pomocą programu VOSviewer wyodrębniono także najczęstsze słowa kluczowe związane z tematyką zrównoważonego uniwersytetu. W części empirycznej wykorzystano statystyki opisowe i testy różnic (U-Man Whitney), aby zidentyfikować istotne statystycznie różnice pomiędzy różnymi grupami studentów w zakresie postrzegania tej koncepcji. W świetle przeprowadzonych badań można stwierdzić, że Politechnika Białostocka podejmuje wysiłki w różnych obszarach zrównoważonego rozwoju. Istnieją jednak określone obszary, w których można wprowadzić ulepszenia, takie jak zwiększanie świadomości studentów na temat strategii zrównoważonego rozwoju uniwersytetu, promowanie krytycznego myślenia i eliminowanie niepewności co do niektórych działań kampusu i zasad zarządzania. W artykule opracowano nową skalę do badania postrzegania przez studentów zrównoważonego uniwersytetu. Zawiera ona 30 pozycji i opiera się na omówionych we wcześniejszych opracowaniach obszarach zrównoważonego rozwoju uczelni oraz uwzględnia nowe kryteria, w szczególności związane z czynnikami ESG.

**SŁOWA KLUCZOWE:** zrównoważony uniwersytet, percepcja studenta, ocena zrównoważonego rozwoju, ESG